

Accelerator Based Experiments status report

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Fermilab Lisle PAC
June 4-8, 2013

Outline

- PPD Support Model
- Energy Frontier
 - CDF
 - Dzero
- Intensity Frontier
 - MicroBooNE
 - Minerva
 - Minos+
 - NOvA
 - Seaquest
 - Test Beam

PPD Historical Support

- Operation of experiments and analysis of data has formally been a responsibility of the experimental collaborations
- Fermilab plays a large role in technical support of operations, and Fermi scientists often spend a larger fraction of their time in experiment support roles than most
- During 1990s-2000's CDF and D0 operated with dedicated operations organizations
 - Led by experiment scientists
 - Dedicated Electrical and mechanical technician groups with engineering leaders - access to other resources on demand (eg accesses and shutdowns)
 - Embedded online support groups led by scientists - access to CD resources when needed
 - During same period fixed target and neutrino experiments had no dedicated operations support
- International Finance Committee's (IFC) provided venue for international oversight, plus funding and in kind contributions for experiment operations

Modified support model for IF

- Intensity frontier experiments did not have Fermilab technical staff devoted to single experiments, and the overall pool was very small.
 - Opportunity to change model at end of Tevatron operations
 - Share resources across experiments, since less need for an individual experiment
- Division Engineering and Technical teams reorganized to support multiple smaller experiments
 - Dedicated operations support groups that cover multiple experiments
 - Include aspects already in place for neutrino experiments (eg Underground Area Coordinator)
 - Treat Testbeam operations like the longer term experiments
- Insert more scientists into Engineering and Technical teams
 - Eric James – Deputy head of Mechanical Engineering
 - Juan Estrada - Deputy head of Detector Development and Operations Dep.
 - Gaston Gutierrez, Steve Hahn, JJ Schmidt
 - Peter Shanahan – Leader of online support group in EED
- Holding regular Experiment Management Group (EMG) meetings
 - Opportunity for experiments to bring issues to lab

PPD Operations Group

- Intensity Frontier and Testbeam Operations Group
 - Responsible for providing first line response experiments
 - Staff of two Application Physicists and three Engineering Physicists with extensive operations experience from Tevatron and testbeam
 - Each experiment has a Primary Points of Contact (POC) and a backup
 - Experiment Run Coordinators (RC) interface directly with POCs to solve problems
- POCs have knowledge of detector systems AND technical resources in PPD and CD
- If possible problem may be solved by POC, otherwise will access appropriate resource
- Two mechanical technicians in this group can solve many problems, particularly at TB

Online support

- Online Support group formed in PPD/EE Department
- Provide support to experiments in development and operations phases
- Maintenance and improvements of online systems
- Front-line response to operational issues
- Direct contact with RCs and POCs
- Coordinate with SCD groups
- Group of four IT Prof and one Eng Phys led by Scientist
- All with extensive online support experience from Tevatron and/or CMS

PPD Technical and Engineering Support

- Infrastructure group in EED provides electro-mechanical technician support plus engineering expertise in power supplies etc
- Technician groups in DDOD provide on-demand mechanical support to repair infrastructure or move detector components
- Engineering in MED provide on demand consultation in solving problems
- Operations support given priority when addressing immediate operations issues
- Demands do not present a significant issue in detracting from Project work
- Building management group supports buildings housing experiments and associated infrastructure
- ESH group, safety committee's – review and approve changes or improvements

DZero – Experimental Facility

After Beam ended - special study runs

- 3 month cosmic run
- calorimeter HV study
- SMT annealing study (Abstract L9.00001 April APS 2012)

Stabilized, secured and shut down cryo & other systems

- LAr transferred, Jan 2012
- LHe to solenoid, photodetectors off Jan 2012
- LCW cooling water shutdown
- SMT chiller shutdown and drained

Detector is stable, and requires little effort at this point.

Exhibit for visitors



“I hear and I forget. I see and I
remember . . .” Confucius

Relocated display of “artifacts” – i.e.
scintillator and silicon microtracker pieces
etc. to larger 1st floor area

Moved magnet iron, forward calorimeter to
improve visibility of inner detector & make
for safe touring

Screen captures recreate displays during
running

1050 visitors since 1 Feb 2012;
440 saw also the Tevatron itself

Dzero component reuse

- Online computing (L3 farm) re-allocated to analysis use
- 11,000 gal of pure LAr stored on-site;
 - 3,500 gal since moved to LAPD
- Muon readout electronics, some HV, blowers, single board computers, rack monitors, turbo pumps cryo components, instrumentation etc., partially harvested
 - Most components still available
- Spare VLPCs to MICE collaboration
- DAB/complex extensively used

D0/DAB Facilities

- Trailer use declining
- Overall goal is to keep D0 people in main building & 151, which has meeting rooms



- Trailer 173 to “go dark” end FY13; 177 was planned next, but Alignment group needs a new home & it will be The Outback
- Outback to Alignment transition already begun & should finish end Oct 2013

D0/DAB Facilities

MicroBoone TPC Assembly



Main building's large hi-bay & 50 ton crane in demand for other projects (COUPP)



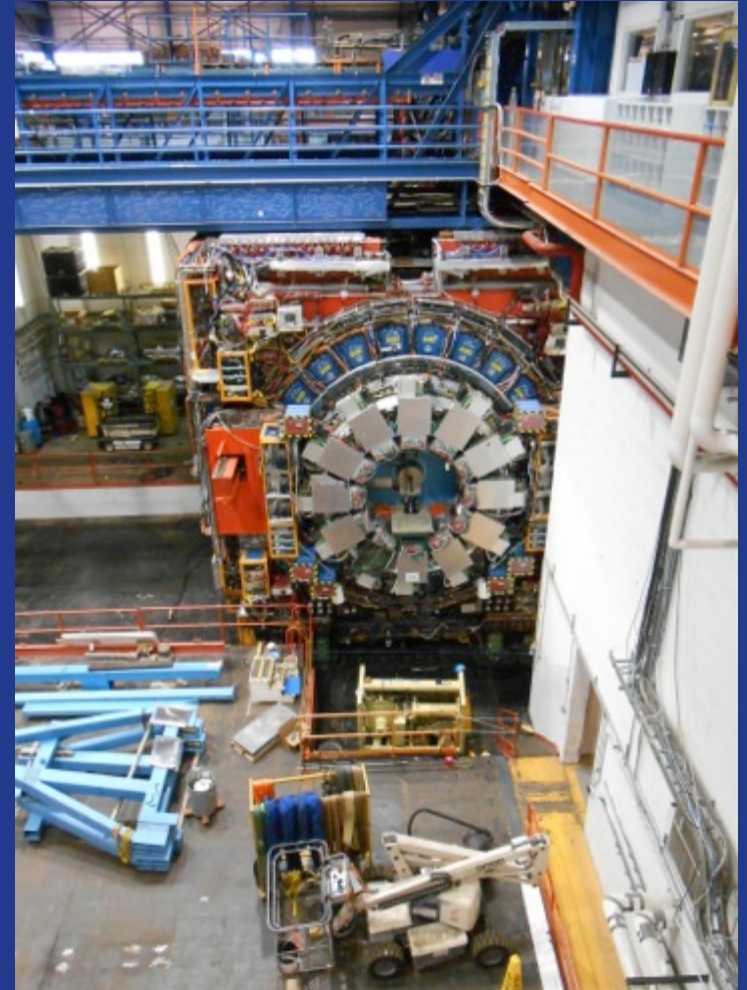
MicroBoone
HV Test



g-2 Straw Test

CDF - Decommissioning and Preservation

- Goal: Preserve CDF assets so they can potentially be used again
 - Solenoid
 - Mechanical systems
 - Electrical infrastructure
- Scope of work
 - Remove tracking detectors and plug EM calorimeters
 - Remove electronics and cabling
 - Dismantle external muon systems
 - Return central spectrometer to collision hall to be ready for modification for future uses



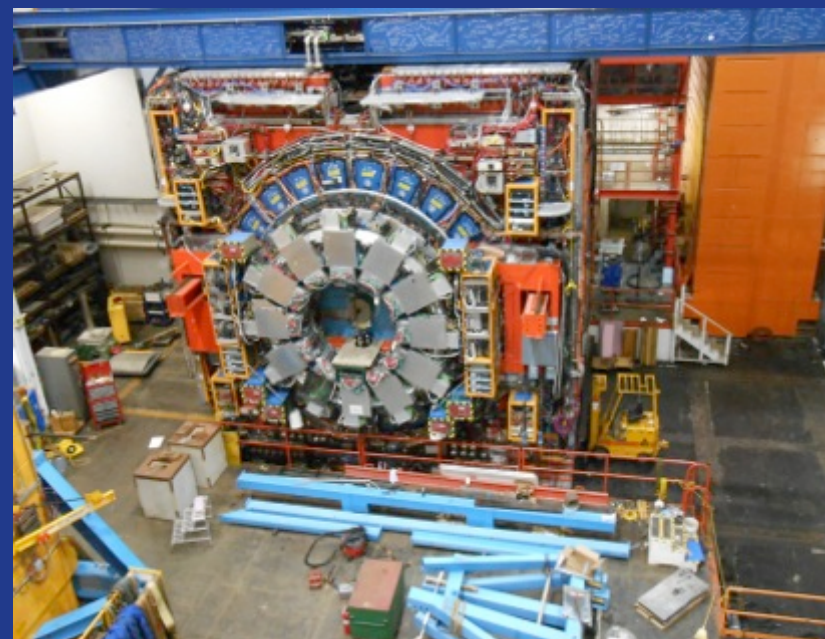
CDF Decommissioning Status

- Heavy lifting
 - NOvA FHEP removed in February
 - Assembly hall cleanup completed in March
 - CDF display items moved to storage
 - NOvA near detector factory on east side
 - Decommissioning has begun
 - Central detector and muon walls in assembly hall pit
 - Started stripping cable carrier
- Rate limiting factor is availability of labor
 - PPD Mechanical Group is oversubscribed
 - Using contract techs and riggers
 - Eight summer students removing cables, electronics, etc.
- Getting estimates for muon wall demolition

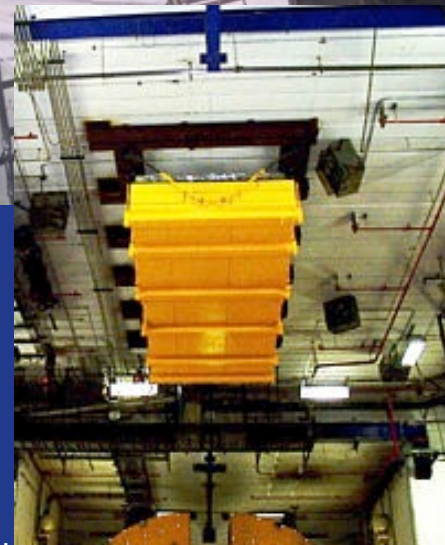
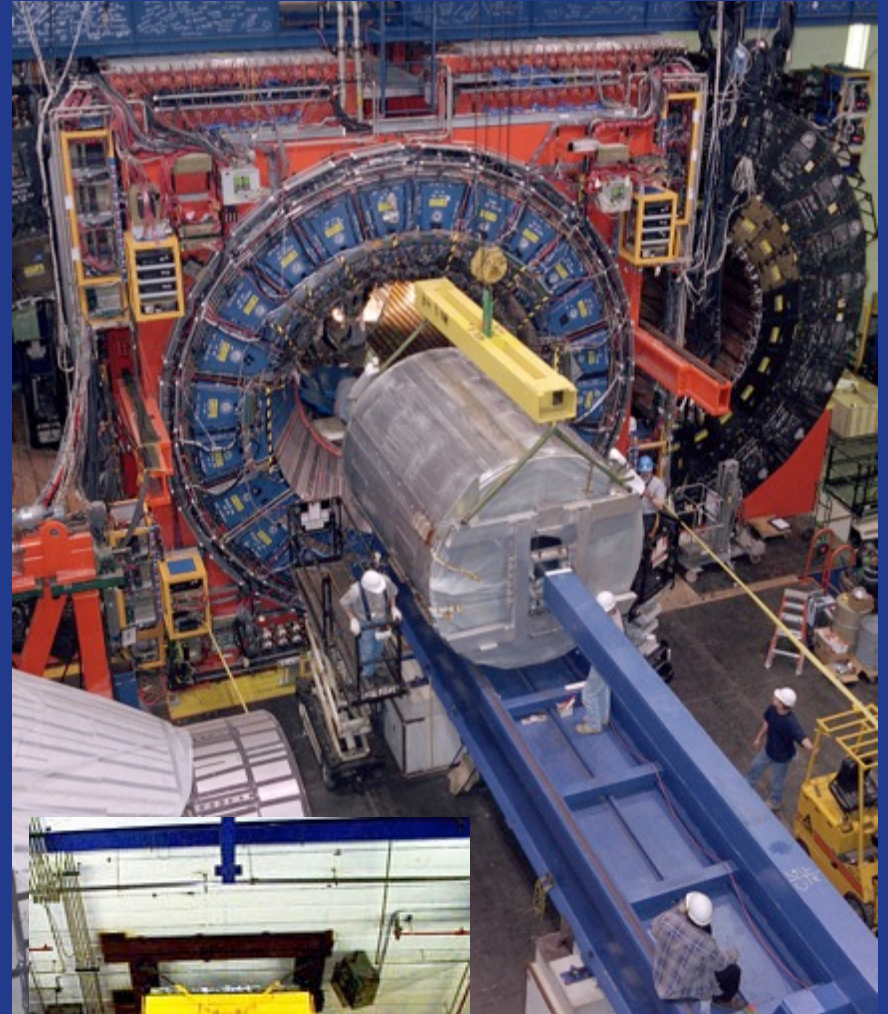
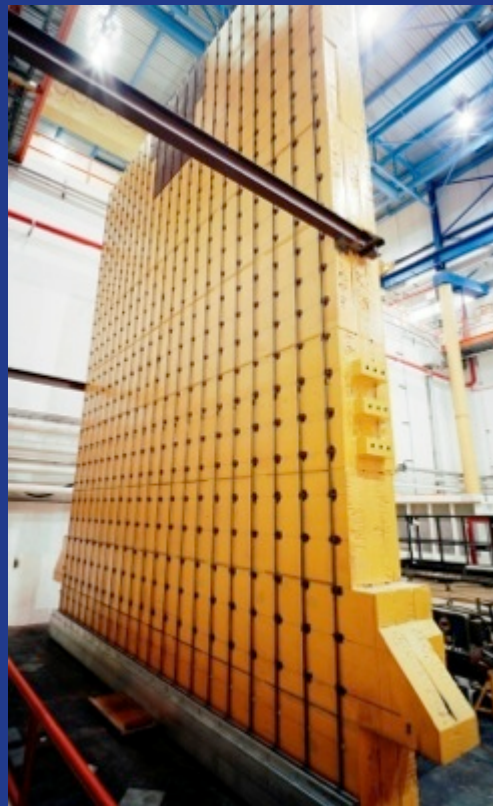
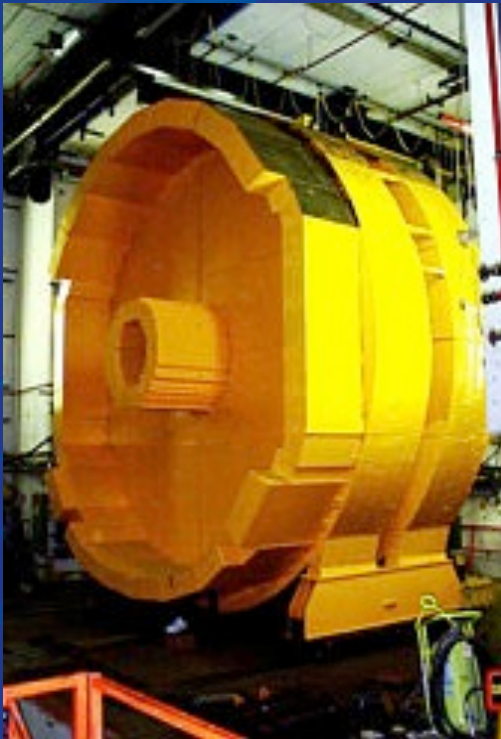


CDF Decommissioning Plan

- FY13
 - Move north muon wall and central detector to assembly pit
 - Remove tracker
 - \$200k budget is just enough based on planning exercise
 - This is base labor from estimate, i.e. **zero contingency**
 - Use summer labor to strip cables, electronics, etc.
 - Recover scintillators, PMTs for IF experiments
 - Can start muon wall demolition if other funds are available
- FY14
 - Remove cable bridge
 - Demolish CMX arches
 - Demolish muon walls
 - Move to assembly pit if funds
 - Return spectrometer to collision hall



D&D Tasks



Lindgren – Fermilab Lise PAC, June 4-8, 2012

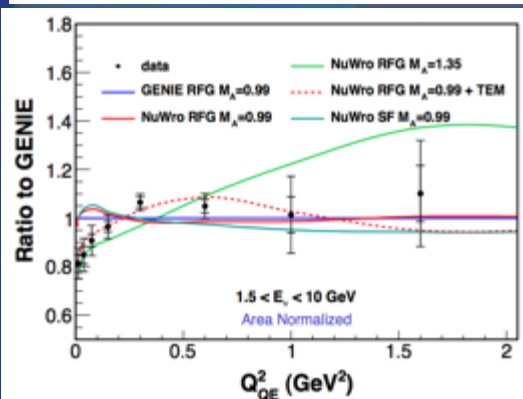
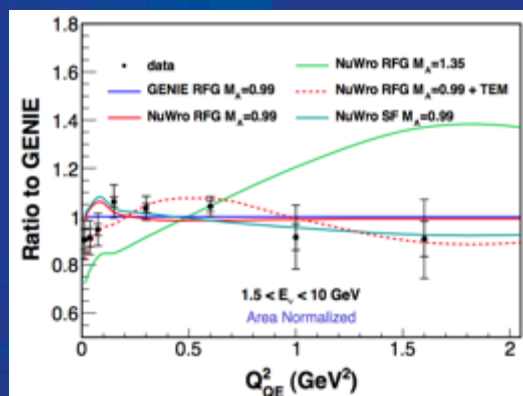
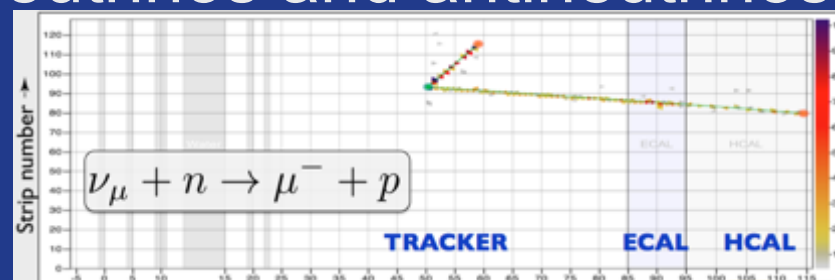
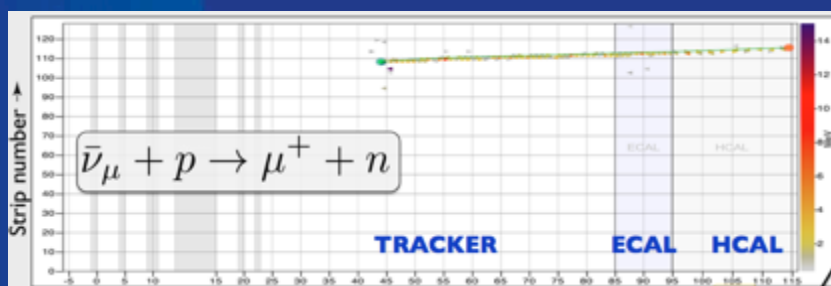
MicroBooNE Status

- Sam Zeller will give report on status tomorrow in detail
- Project is progressing extremely well
- LArTF building is complete

MINERvA First Publications

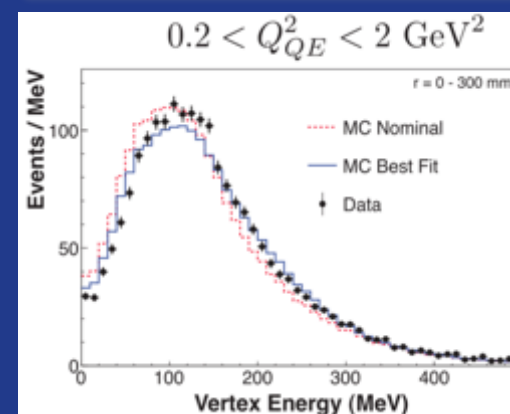
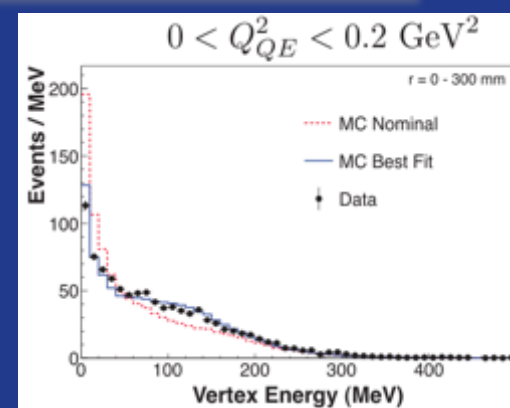
*arXiv:1305.2234
and 1305.2243*

- Quasi-elastic interactions of neutrinos and antineutrinos



Results show that simple model of independent nucleons inside a carbon nucleus is NOT best description of what actually happens:

- Muon kinematics are different (left)
- Recoil (non-muon) energy is also not as expected (right)

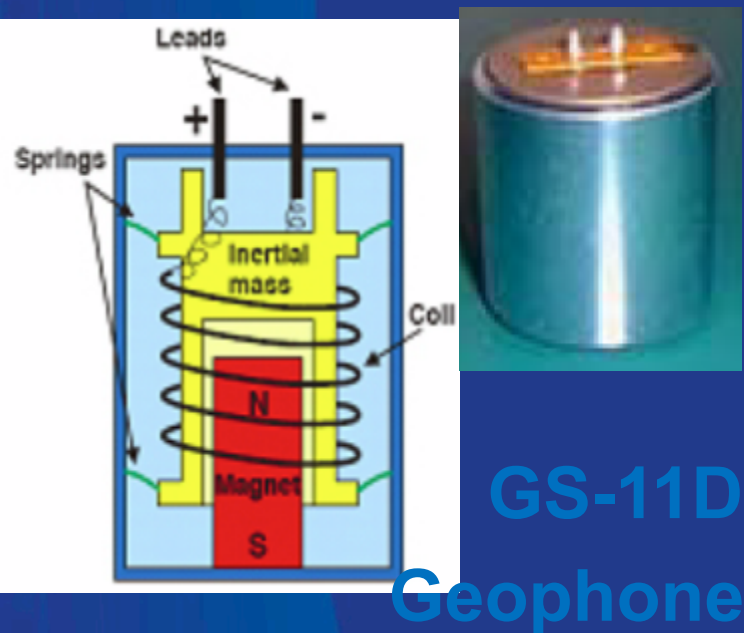


Minerva Detector Status

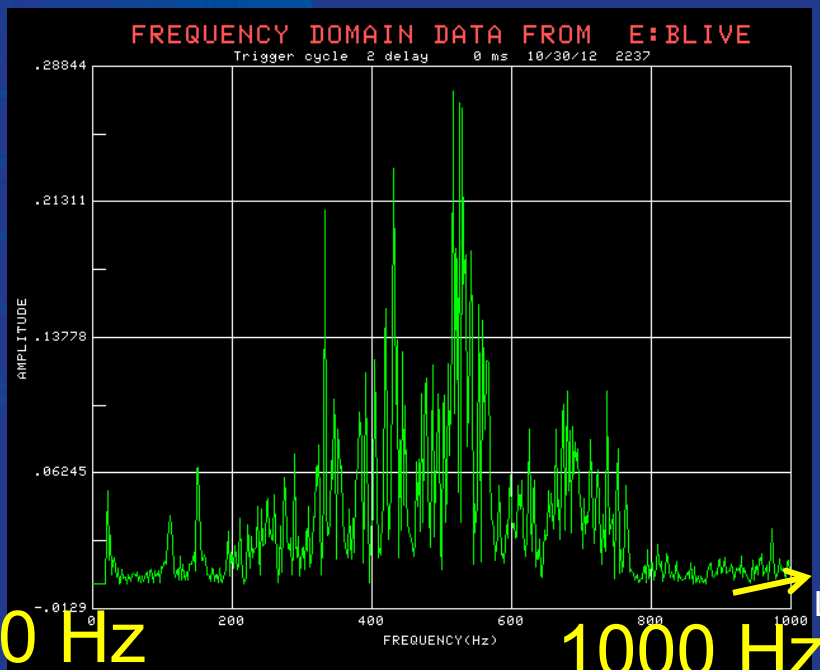
- The major source of MINERvA downtime during LE Run was due to debris & water falling from ceiling on the detector
- New herculite roof installed at the beginning of the shutdown
- Vesda System (smoke detection) and readout in place
- Temperature rate of rise sensors and readout installed
- The 4 cameras installed to look at the detectors
 - 3 cameras on detector & on electronics rack
 - The output to a WEB page
- Rack protection system is connected to the FIRUS system
- By the end of the shutdown the roof was upgraded to include sheet metal so water does not pool on the roof



Monitoring MINERvA during NOvA Excavation



- Some indication that vibrations 500-1500 Hz at about 1 g could damage the PMTs if HV on.
- Expect vibrations 10-50 Hz with velocity ~ 0.07 mm/sec at detector
- Geophones on the MINERvA PMT measure the vibrations
 - Thanks to Todd Johnson (AD) & Linda Bagby (PPD EE Dept)
- Measured
 - max velocity=0.33 mm/sec
 - FFT done by MCR gives 400–500 Hz,
 - At 500 Hz this is about 1g



Minerva –

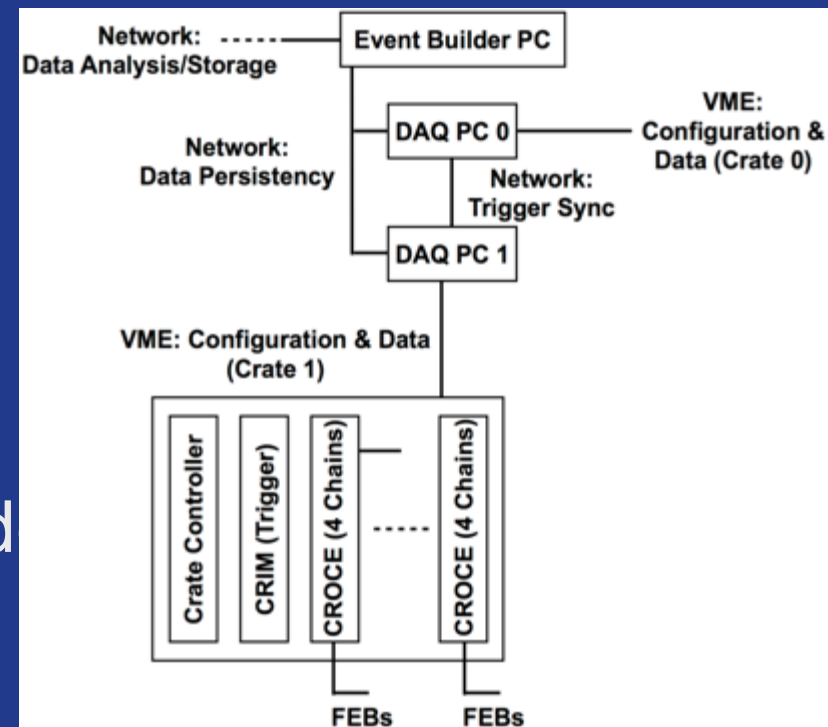
- PMT voltage off during excavation
- Pedestal and light injection calibration data during short periods when no excavations were being done
- No loss of channels seen
- After excavation was over, ran DAQ for longer periods of time, and a new problem has developed: the DAQ stops after several hours of running
- Software reset fixes the problem so we can take data when beam returns, but with lower livetime (LE run integrated livetime is >97%)
- Likely culprit is a particular module (CRIM)

Minerva Shutdown Detector Work

- Light Leak fixes
 - A few light leaks were introduced when water target was installed in 10/2011, had to blank out several channels in nuclear target region
 - The light leaks have been fixed so the detector now has more live channels than at the end of the LE run
- Cryo-cooler refurbishment
 - Finished the LE run with an empty Cryogenic target for background studies for He cross section measurements
 - Refurbished the cryo-cooler to increase expected lifetime to >10 months which is time to next shutdown
- DAQ Upgrade
 - Original DAQ designed for 2.2 sec cycle time, need to make slowest step in the chain faster to take 1.3 sec. cycle time data

Minerva CROC-E Upgrade

- New CROC-E boards replace CROC boards (CROC talks to FEB, front end board)
 - Reduces readout time to 1.2 sec for 1 beam & 5 calibration events
 - Use 15 of these boards in the detector, will only take a day or two to install once they are ready
- DAQ software modified
- The readout is made more parallel. Instead of looping over FEBs, it loops over channels in the CROCs.
 - Decreases readout time by factor of 10
- All boards designed, assembled, d during the shutdown
- DAQ test stand set up at D0
- Test CROC-E's on DAQ test stand then install underground

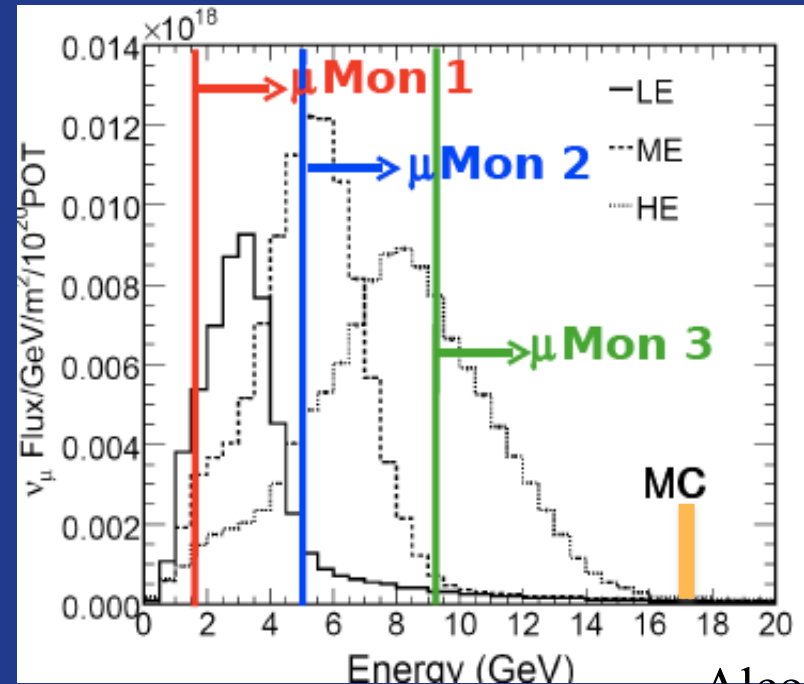


Minerva Helium Target Run Plan

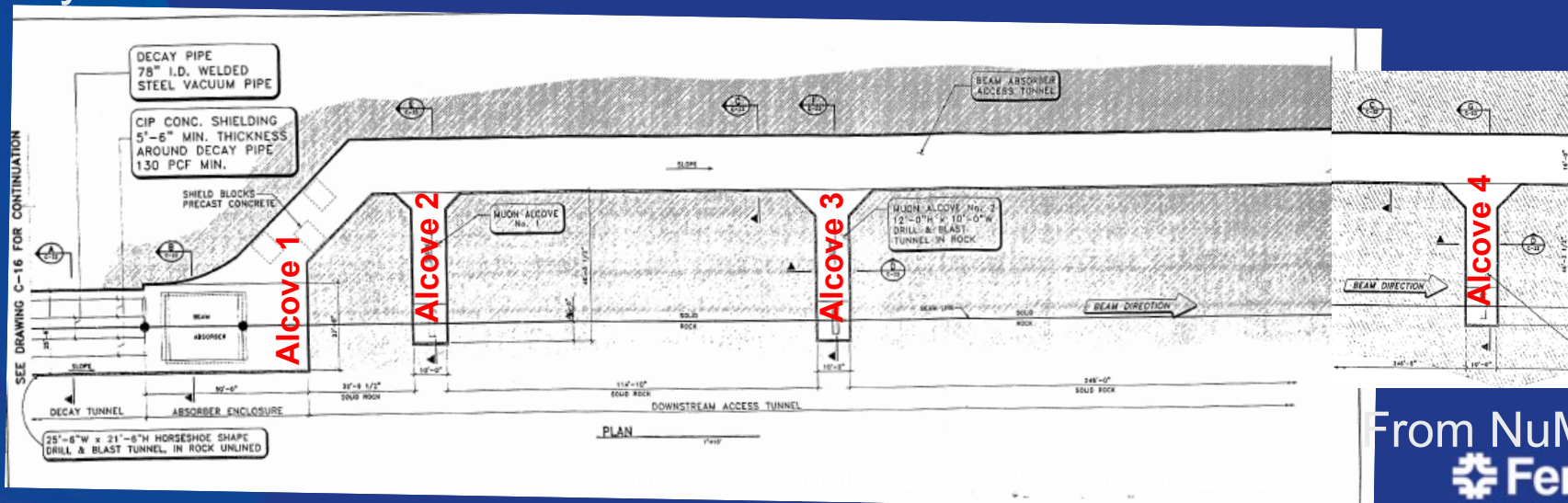
- Helium Cross section measurements need about 20% empty target running for background subtraction
- Need to take empty target data in both neutrino and antineutrino mode, knowing how many POT in each mode in advance would allow us to maximize physics output per POT
- Filling the helium target costs about \$20,000 and takes ~1 month, want to minimize number of fills per mode
- NOvA's request for beam was for "neutrino mode until a 4 sigma appearance result is reached"
- Will want to extrapolate POT exposure required early enough in the run to get enough but not too much empty target running
- Plan minimizes He expense
- Empty and fill during beam periods

4th Muon Monitor for NuMI

- Low Energy Beam instrumentation:
 - 3 alcoves, each with higher muon energy threshold
 - 2 alcoves see “focusing peak”, last alcove only sees high energy tail
 - Last alcove important baseline for comparisons
- Going from LE to ME configuration:
 - Alcove 3 no longer sees only the high energy tail
 - Instrumentation in 4th alcove installed for the best information from the system
- Monitor installed, but gas system not ready



Alcove 4



From NuMI TDR
Fermilab

MINERvA Test Beam

- TB in 2010 focused on low energies
- Experiment would like TB run at higher energies in 2013, to match NOvA era beam
- Detector was partly disassembled after 2010 run
 - Estimate 3 FTE months of mech. techs. & 10K M&S
- Photosensors for 2010 run were borrowed from the main detector
 - Need 40 PMTs; have ~15 spares
 - Puzzling cross talk issue in tubes
 - Working on understanding this



MINOS+

- Very successful MINOS program has completed long run.
 - Since 2005 for Low Energy NuMI beam, longer for atmospheric.
- Emphasis now changes to MINOS+ in ME beam.
 - Validation of 3-neutrino model
 - High-statistics spectral shape, extend sterile limits, limits on alternatives.

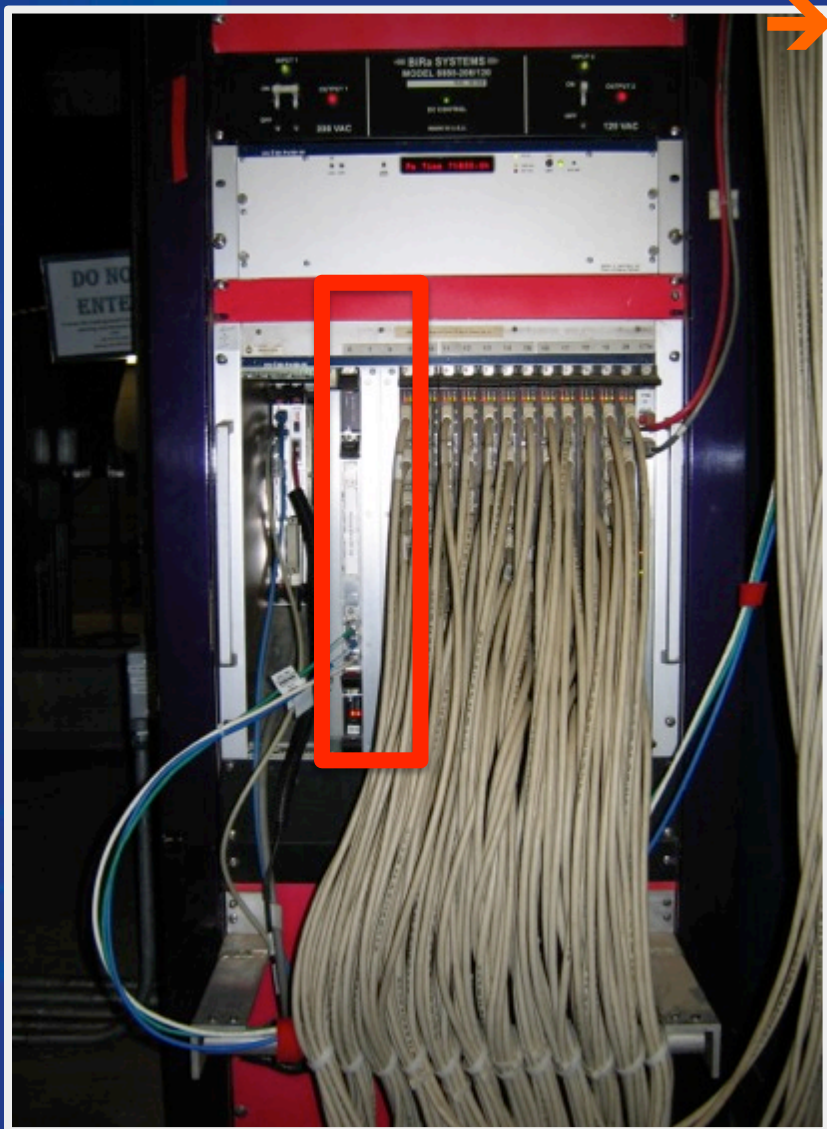
MINOS+ Detector Status

- Well understood detector
- Will begin data taking at accelerator startup in 2013.
- New Near Detector DAQ tested, running. Only significant configuration change.
 - Improve maintainability.
 - Recycling of Tevatron program components.
 - Can be extended to Far Detector in future.
- Data taking for 3 years – 3000 CC events per year between 4 and 10 GeV.
- More at: www-numi.fnal.gov/MinosPlus/pr_plots/minosplusbragslides.pdf

MINOS+ Near Detector DAQ Changes

Original System heavily dependent on parts no longer available

→ Standardize



- Front ends unchanged
- Timing rack unchanged
 - Master racks:
- Added MVME 5500 in 6U-to-9U adapter with Gigabit Ethernet, serial, and reset cables
- Tested in all Master crates to not interfere with existing DAQ

MINOS+ ND “Refurb” DAQ

Center
rack with
door open:
“refurb”
DAQ



3 racks
with grey
computers:
old DAQ

Near Detector DAQ Refurbishment: a major rework of the DAQ architecture to eliminate reliance on obsolete and aging components.

- Replaced CES RIO VME processors with Motorola VMEs harvested from CDF.

- Replaced aging, unstable, obsolete proprietary data network with gigabit Ethernet.

- Simplified architecture to replace several different computing nodes used for event building and triggering with a single node. Automatic fail-over to a backup node.

- Upgraded software for modern operating system (SLF6)

 - Software was originally developed more than 10 years ago.

- Completed and tested. Final testing by comparing data taken with new and old system is in progress.

Minos+ Other Detector Work

Simple RPS to drop power in rack if smoke detected

Far Detector DAQ refurbishment has started, but at a lower priority.

Spares situation at Far Detector is less critical

Other DAQ Support

Built test stands for Near and Far Detector DAQ systems

Reworked Run Control to remove reliance on MINOS-specific adaptations of external packages

Underground area network upgraded (SCD)

MINOS ND magnet coil on since 01/30

MINOS+ Reconstruction Status

- Reconstruction needed to be updated for higher expected event rate
- “Reconstruction” software also performs last stage of event building.
- Optimized code runs factor of 2-3 faster.
- New “slicing” algorithm implemented.
- Now needs benchmarking with DATA.
- One element of calibration chain has technical problems, resolution expected soon.

MINOS+ Analysis Status/Plans

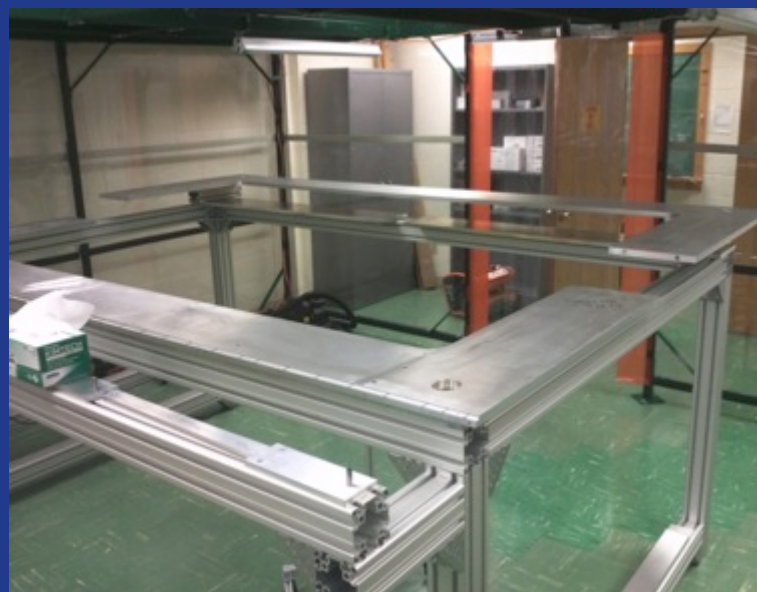
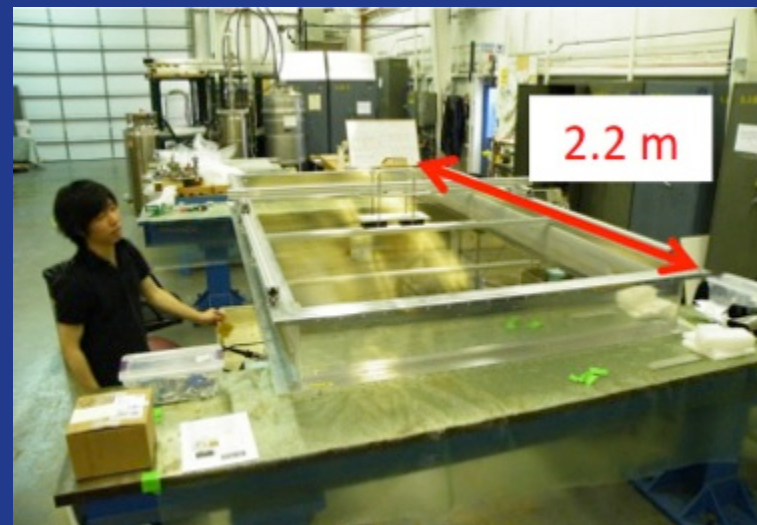
- MINOS Analysis still ongoing.
 - Now in final analysis phase
 - Published Atmospheric results, complete θ_{13} study, have submitted combined disappearance analysis paper.
 - Number of topics still to come
 - NC with sterile limit, 3-neutrino framework analysis, combined ν_e and disappearance, “big PRD”, several others
- Now planning for MINOS+ analyses
 - Firstly, confirm shape of oscillation curve and measure parameters in ME beam
 - Sterile neutrino limit
 - Some analyses require antineutrinos.
 - Plan to align student and postdoc effort at Ely meeting in two weeks.
- Experiment and collaboration in good shape

NOvA Status

- Gary Feldman will discuss NOvA preparations in detail tomorrow
- Project has >half of the blocks in place, one Kiloton read out.
- Near Detector Cavern complete - Kiewit did a terrific job
- Near Detector block assembly ready to begin
 - Muon catcher steel harvested from NDOS

SeaQuest Shutdown Work

- New “station 3-” wire chamber:
 - Japanese group
 - Assembly (including wire stringing) in Lab 6
 - Ready to go
- New “station 1” wire chamber:
 - U. Colorado group
 - Assembly in Boulder
 - Probably won't be ready for installation before start of run.
- Beam Intensity Monitor
 - Cerenkov counter in NM3 (ANL/FNAL)
 - Dynamic range $\sim 400 - 4,000,000$ protons/RF bucket
 - Single phototube with fully transistorized base



SeaQuest Shutdown Work (2)

- Rebuild phototube bases for higher rate capability
 - UIUC group (FNAL design).
 - Allows $\sim x10$ in anode current.
 - Bases are being rebuilt now; will be ready for run.
- New TDC microcode
 - Taiwanese grad student (w/ guidance from FNAL engineer).
 - Better time resolution and $x10$ less readout deadtime
 - All TDCs have been reprogrammed and tested.
- Spare cryogenic target flasks built.
 - FNAL technicians & machinists.
 - Testing complete.
 - Documentation & safety review not yet complete.

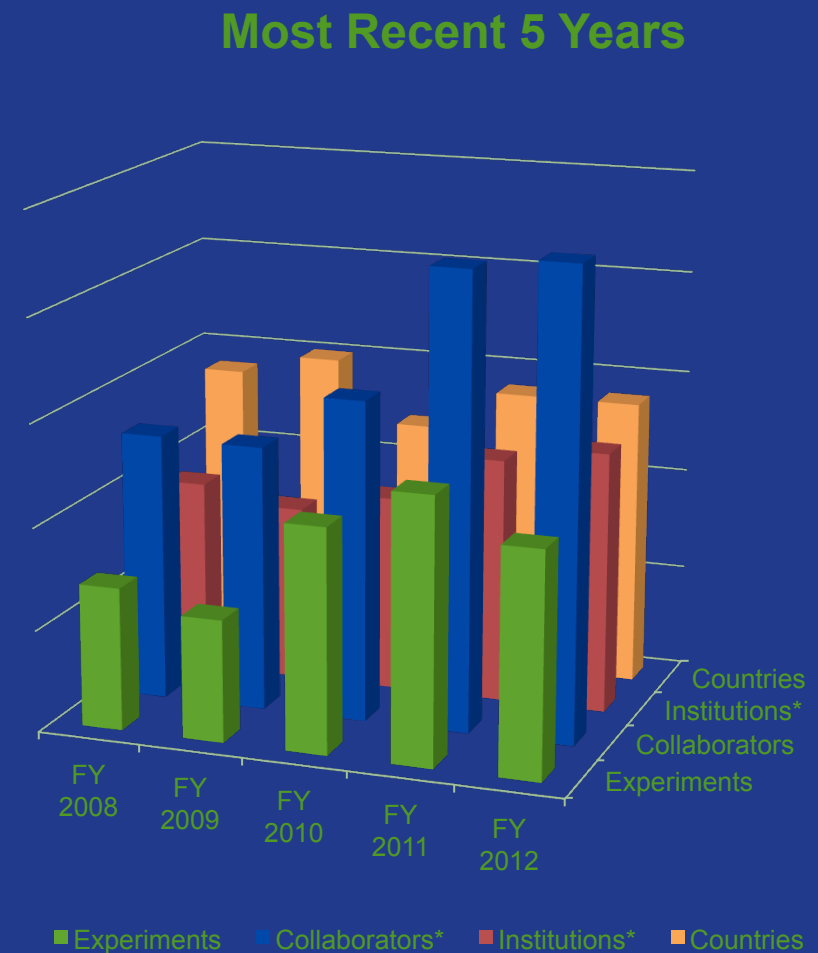


SeaQuest Startup Status

- Expect beam late August (critical path is beam pipe repair).
- Spectrometer will be ready except for new station 1 drift chamber
 - Will continue to use old chambers from E866 (small impact on physics until highest luminosity running).
- Schedule for station 1 installation will depend on construction timeline and accelerator performance
 - Most important unknown is the length of time that will be required to establish high duty factor slow spill.

The Fermilab Test Beam Facility

- Detector R&D focus
- In 2012:
 - 11 experiments
 - 229 collaborators
 - 64 institutions
 - 14 countries
- Only US HEP Test Beam operating now



*Number of *Collaborators* has been scaled to fit on plot

*Number of *Institutions* has been scaled to fit on plot.

◆ FY12 only consisted of 7 months of Beam

Meson Test Beam Infrastructure

- Large main enclosure MT6.2 insulated to provide better temperature/humidity environment for all experiments. New smaller hut MT6.2C can provide even more cooling for SiPMs or other sensitive detectors.
- Physical infrastructure for HV, signal, and network cables redone with patch panels between enclosures and electronics room. Signal cables between panels have known and uniform lengths.
- Network switches upgraded to support gigabit and wireless coverage expanded to entire area.
- New internet cameras with pan/zoom/tilt installed in all enclosures.
- New laser beam alignment system installed in all enclosures.

Meson Test Beam Infrastructure (cont'd)



Insulated MT6.2
Enclosure



New MT6.2C Hut with
Motion Table

Meson Test Beam Infrastructure (cont'd)

- Control rooms remodeled with new paint, carpet, and furniture.
- Electronics room rearranged to support more racks and separate experimenters' equipment from permanent equipment.
- Motion table control systems redesigned for three tables.
(85% complete – will be done by July)
- Training/practice interlock gate built to reduce downtime due to dropped interlocks during controlled accesses.



Control Room Remodeled



Controlled Access Practice Gate

Instrumentation

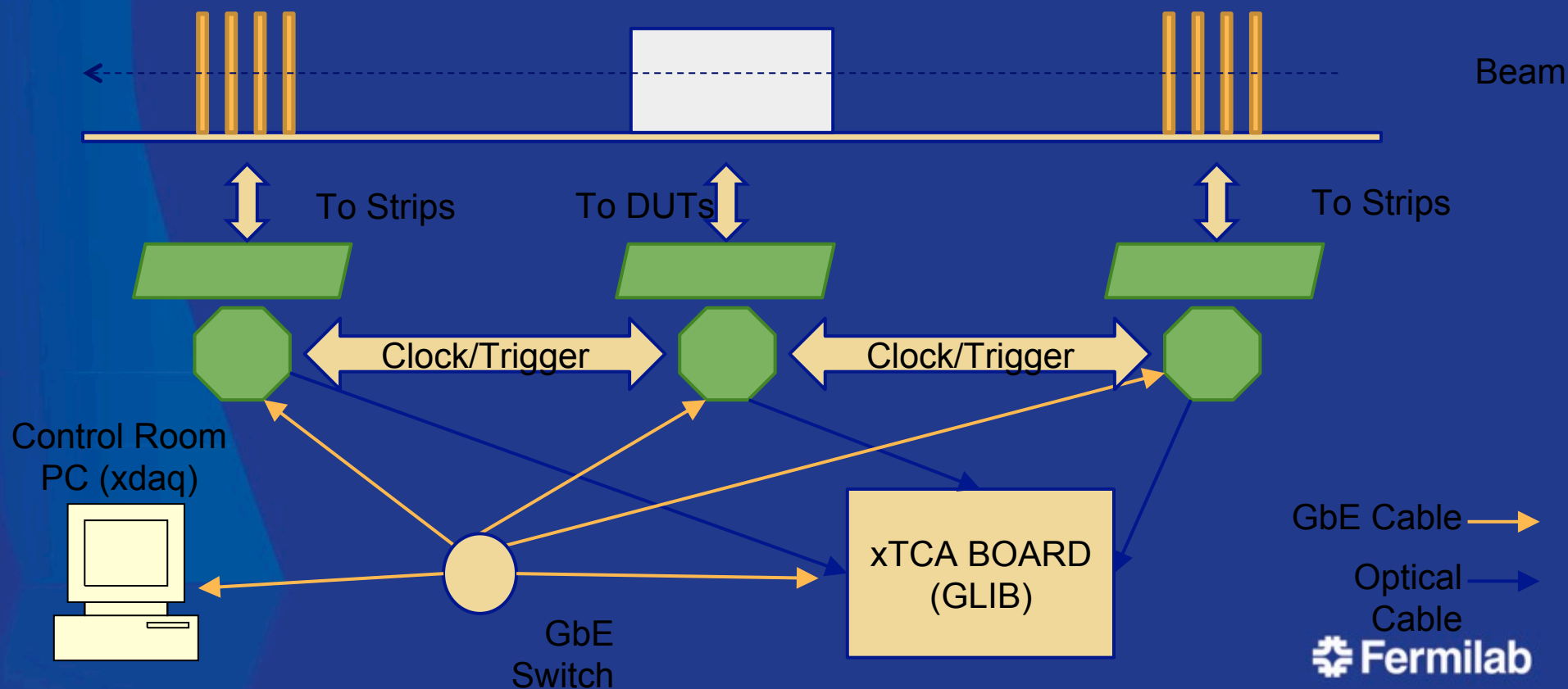
- Major upgrade to MWPC tracking chambers.
 - Fenker chambers rebuilt with new readout electronics (ASDQ card -> TDC board -> TDC controller board) designed by Sten Hansen. (all electronics out for fabrication and due by end of June)
 - Extensive testing done to understand optimal gas for efficiency and cost.
 - Extensive work done to lower noise.
 - Five chambers (x-y) planes in production with plans to build at least four additional for use in new MCENTER test beam line.



New MWPC
Testing

Silicon Strip-Based Telescope for FTBF

- The Detector Instrumentation Group of ESE/SCD in collaboration with Purdue University will commission a new strip telescope when the beam returns this summer. The telescope will be available to provide precision tracking for users as part of the Fermi Test Beam Facility.
 - Telescope DAQ includes CAPTAN (Fermi design), MicroTCA GLIB (CERN design), and xdaq (CMS software framework).
 - Will leverage past experience of CMS pixels-based telescope and CAPTAN DAQ.
- Features: up to 16 planes with 60 micron D0 strip sensors, large active area (up to 8cm x 8cm, 25x area of pixel telescope), ~5 micron resolution anticipated, real-time track reconstruction in MicroTCA form factor.
 - The strip readout chip is the FSSR2, which was designed at FERMILAB for the BTeV strip detector.



Mcenter work

- MCenter beamline is being recommissioned to provide additional resources for larger and longer term test experiments.
- Four primary magnets still need to be changed out – waiting on personnel resources to be freed from shutdown work.
- Radiation assessment underway.
- Upstream MC7 area cleared out for experiments and physical infrastructure (ductwork, electrical, signal and HV cables) put in place.
- Tertiary beamline with power has been moved but not fully configured.
- Working on Cherenkov and MWPCs for this area.
- Plans are underway to make old MWest beamline stub into control room.
- First customer is LArIAT – “Liquid Argon in a Testbeam” with first phase using the *ArgoNeuT* cryostat which is in place. Cryogenics system in design phase.
- Target timetable is fall of 2013.

Facility Expansion - HRT

- “High Rate Tracking Area” is under development in an M03 alcove upstream of target for MTest beamline. Flux will $\sim 1\text{E}12/\text{minute}$ and two customers are scheduled for late summer and early fall.
- Electrical power, networking, signal, and HV cables are in place.
- Tap into LCW will be done soon.
- Beam intensity monitor based on Seaquest design will be permanent addition to area.
- Three electronics racks have been setup in MS3 for “control room”.
- Motion table under design for this area.



MT3 High Rate Tracking Area



HRT racks at MS3

Experiments Coming Soon

- List of approved or submitted experiments can be found at <http://www-ppd.fnal.gov/FTBF/TSW/index.html> .
- Partial list....
 - T-1042: Muon g-2 straw tracker
 - T-1041: CMS Forward Calorimetry R&D
 - T-1038: PHENIX Muon Piston Calorimeter APD and Prototype MPC Extension Tests
 - T-1037: FLYSUB: Consortium Tracking and RICH Performance Evaluation
 - T-1036: Tests of high rate pixel detector
 - T-1034: LArLAT: Liquid Argon TPC in a Test Beam
 - T-1031: ATLAS Tile Calorimeter Upgrade Electronics Tests
 - Other returning experiments
 - Expressions of interest from many more.

Summary

- Detector operations support model revamped to meet need of intensity frontier program
- There has been a lot of work done during the shutdown to prepare for the next running period
- Experiments are ready, or will be, when beam returns
- NOvA has one kiloton complete now, will be largest detector in Minnesota by the end of the summer
- MicroBooNE and NOvA near detector facilities ready
- Test beam continues to evolve and improve